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THE somewhat formidable number of serious diseases of *Hevea brasiliensis* in Ceylon has been compensated for, to some extent, by an almost entire absence of insect pests of this tree. The few local insects which have been associated with *Hevea* in the past are of minor importance and their occurrence is so occasional, and so rarely reported, that they cannot be regarded as pests of any significance.

It has always been considered a matter for congratulation that Ceylon rubber estates enjoyed immunity from the attacks of termites, especially in view of the important status of these pests on rubber estates in Malaya and the Dutch East Indies.

In the past, records of these insects being associated with *Hevea* in Ceylon appeared to be confined to dead or diseased trees and it was assumed that the termites were not pests of primary importance. (1) Unfortunately, this view can no longer be entertained and there is reason to believe that the concern with which these pests have been regarded by the tea planter for many years must, in future, be shared by the rubber planter also.

WHAT TERMITES ARE

It might be advisable, at this stage, to explain briefly what termites are. They are better known as "white-ants," but belong to the insect order Isoptera and are in no way related to the true ants (Hymenoptera). The term "white-ants" is an unfortunate one and has led to much confusion. Their more correct name, termites, is preferable. Termites may, for all practical purposes, be grouped into two classes, depending upon whether they nest in the soil, or above it in trees and timber.

Those which nest in the soil usually exist in large societies and several forms of the same insect may be present in the same community. In a typical colony of this type the activity of the

nest centres around the royal pair, which, in the early stages of the society, are the original founders of the colony having been derived from a pair of the winged stage. When the colonising flight takes place, the males and females pair off, shed their wings and enter the soil at a suitable spot to commence the establishment of a new colony. Often the royal pair are enclosed in an earthen cell which is designated the "royal chamber," or "queen cell," and within this abode the queen undergoes a very considerable distention in size often attaining a length of $2\frac{1}{2}$ inches or more. The royal pair are cared for by the "worker" caste, considered to be neuters incapable of further development. The workers feed the king and queen and remove the eggs, as soon as they are laid, to sites which have been prepared for their reception. "Soldiers," which possess formidable jaws which they use to advantage in defending the society against other insect enemies, are also present and there may occur nymphs, about to develop to the winged stage, or the winged insects themselves awaiting a suitable opportunity of embarking on their colonizing flight. This type of soil-nesting termite is represented, locally, by several genera among which may be mentioned the mound-builders *Hypotermes* and *Cyclotermes*, and *Termes*, *Leucotermes* and *Coptotermes* which erect no superstructure above their nests. More will be said of *Coptotermes* later.

The termites which nest above the soil in trees, building woodwork and other situations also commence their colonies from winged stages but the queen undergoes little increase in size. There is no worker caste, all individuals, with the exception of the soldiers, being destined to develop to reproductive adults either with, or without, wings. Usually the latter type of adult is produced only in the absence of one, or both, of the true royalties. The colonies produced by this class of termite are small when compared with those formed by the ground-nesting types. The local representatives of this group are species which belong to the sub-genera *Calotermes*, *Neotermes*, *Glyptotermes*, *Cryptotermes* and *Planocryptotermes* of the genus *Calotermes*, and many species are very serious pests of economic crops in the Island.

Figures of larvae, a soldier and a winged adult of *C.* (*Glyptotermes*) *dilatatus*, which may be considered typical of this group of termites, are shown in Plate I.

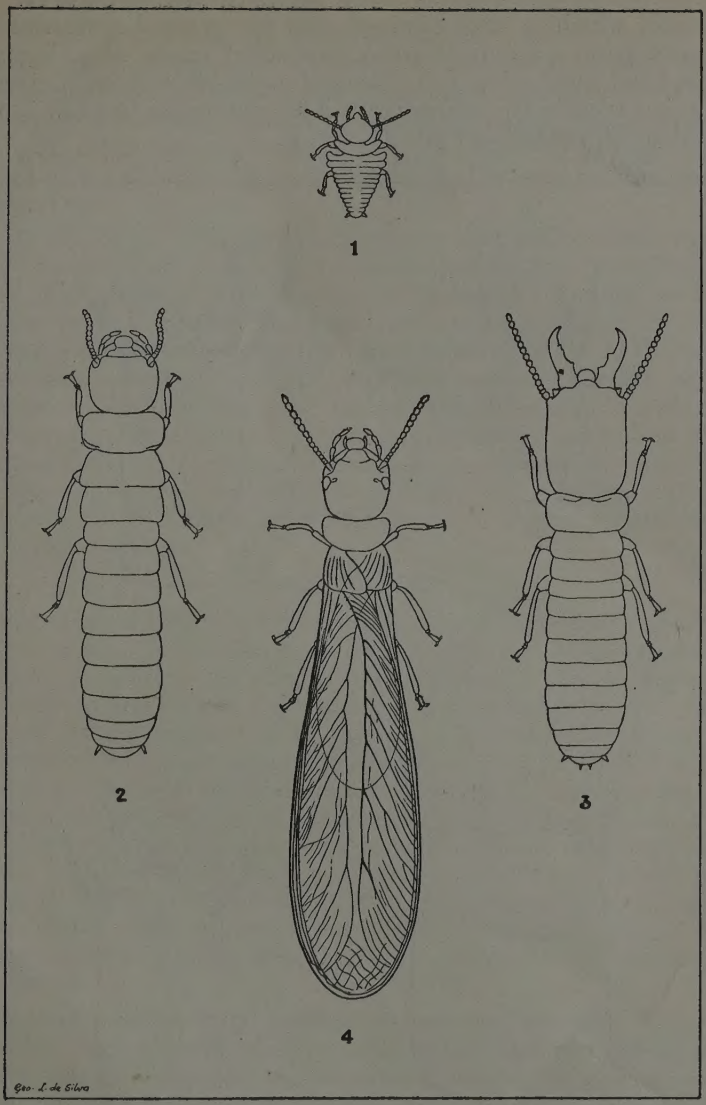

Plate I. *Calotermes (Glyptotermes) dilatatus*

Fig. 1. First stage larva X 10.
Fig. 2. Full-grown larva X 10.
Fig. 3. Soldier X 10.
Fig. 4. Winged adult X 10.

The determination of different species of termites is usually made by an examination of the "soldier" caste. The heads of the soldiers are hard and chitinous, pale, or dark, brown in colour and furnished with prominent mandibles. The arrangement of the processes, or "teeth," on the inner margins of the mandibles is an important specific character. The heads of the soldiers of

the species discussed in this article are illustrated in Plate II. A character which at once distinguishes the genus *Coptotermes* is the possession of a pore situated, anteriorly, on the upper surface of the head and from which a drop of milky-white fluid is ejected if the insect is on the defensive. The gland may be seen in the specimen illustrated in Plate II, fig. 1.

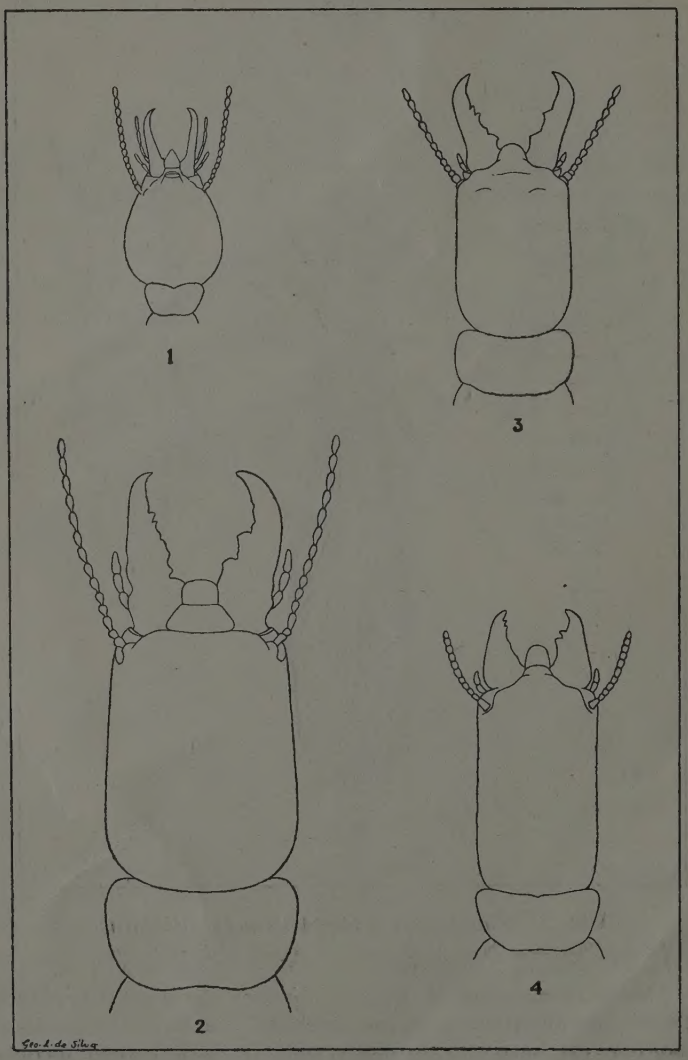

Plate II. Heads of soldiers of termites which attack *Hevea*.

Fig. 1. *Coptotermes ceylonicus* X 15.
Fig. 2. *Calotermes* (*Neotermes*) *greeni* X 15.
Fig. 3. *Calotermes* (*Glyptotermes*) *dilatatus* X 15.
Fig. 4. *Calotermes* (*Glyptotermes*) *ceylonicus* X 15.

If living termites are found to attack a rubber tree under circumstances in which no external, or internal, communication with the soil is maintained, the insects are, almost certainly, a species of *Calotermes*. If, on the other hand, there is definite communication with the soil, such as by runways up the stem, the species will probably be found to belong to the genus *Coptotermes*.

It should not be assumed, however, that any termites which travel up the main stems of the trees beneath the protection of earth-like coverings are injurious as many soil-nesting species behave in this manner and feed only on loose flakes of bark without actually penetrating the cortex to the wood. At the same time these coverings of earth, sometimes enveloping the entire stem some way up the tree, are not desirable and should be removed by the tappers. The only permanent method of preventing their recurrence is to locate the nests and destroy them by injecting petrol or carbon-bisulphide, or by fumigating the central nests with arsenic and sulphur fumes, calcium cyanide or other preparation.

CALOTERMES

In August 1929, a termite which is a very prominent pest of tea on many low-country estates, *Calotermes* (*Glyptotermes*) *dilatatus*, was found invading the sound wood of a *Hevea* tree on an estate at Ingiriya in the Kalutara district under such circumstances as to suggest that, given a suitable point of entry, termites of this genus were capable of causing extensive injury leading to the ultimate death of attacked trees. In this case the original invasion of the tree appeared to have been made at a spot affected by *Ustulina* and there was no doubt that the young colony had originated from a winged pair of adults which had alighted on this spot and effected an entry through the diseased tissue which would present little obstruction to their passage, the young eventually penetrating from this centre to the heartwood of the tree.

Four months later another record was received from an estate in the Ratnapura district, only in this case the species was *Calotermes* (*Neotermes*) *greeni*, also a pest of tea and of many trees, particularly *Grevillea robusta* in many parts of the Island. This species has been collected at various centres from sea level to about 5,000 feet elevation and as wide apart as the Southern and Northern Provinces. The facts of this invasion, which was extensive, left no doubt as to the potentiality of *Calotermes* as a major pest of *Hevea*, under certain circumstances. The entry to this tree had been effected through the decayed end of a branch which had probably been snapped by wind or other agency. The galleries extended down this dead limb to, and into, the main

trunk of the tree. Typical galleries formed in *Hevea* by this species are illustrated in Plate III.

(Photo. by F. P. Jepson).

Plate III. Branch of *Hevea* split open to show galleries formed by *Calotermes (Neotermes) greeni.*

The circumstances under which earlier records of termite association with *Hevea* had been made were then investigated. Only one case of *Calotermes* invasion was forthcoming, from the Elpitiya district, but in this case the tree was dead and only a stump about 9 feet high remained. This was riddled from the top to the roots by two species of *Calotermes*, viz. *C.* (*Glyptotermes*) *dilatatus* and *C.* (*Glyptotermes*) *ceylonicus*. It was impossible to decide at the time of this record whether these termites had caused the death of the tree or had invaded it subsequent to its decay, but in view of more recent records it is very probable that the death of the tree was directly due to the attacks of these insects.

In January 1930 a further case was reported from the same estate in the Ratnapura district referred to above, only in this case the species was *C.* (*Glyptotermes*) *dilatatus* and there was evidence that entry had been effected through a broken branch attacked by *Ustulina*. The galleries formed in this branch by this species are shown in Plate IV. In March of the same year two *Hevea* trees in the Heneratgoda Gardens, Nos. 108 and 142 planted in Plantation No. 2 in 1887, were found to be attacked by *C.* (*Neotermes*) *greeni* and here, also, entry was made through decayed limbs.

(Photo. by F. P. Jepson).

Plate IV. Branch of *Hevea* split open to show galleries formed by *Calotermes (Glyptotermes) dilatatus.*

During April of the present year, in the Peradeniya district, the stump of a dead *Hevea* tree was found to harbour a colony of *C.* (*Glyptotermes*) *ceylonicus* the species which had been found previously in the Elpitiya district in 1925. The stump in question was affected by *Ustulina* but the previous history of the tree is unknown. In this case the colony was confined to the base of the stump and it is possible that termite entry occurred subsequent to the death of the tree.

It will be noted that in three of the above records the attacked trees were also affected by *Ustulina* and it is very probable that the decayed wood beneath the rotten bark where the disease occurred provided the winged termites with the opportunity they sought, and required, of gaining access to the heartwood of the trees. In the other cases the decay of fractured branches served the same purpose. In the absence of such essential points of entry it is considered that no species of *Calotermes*, in the winged adult state, could become established in *Hevea* trees and the prevention of attack is, consequently, dependent upon attention being directed to these points, *Ustulina* patches being treated and the factors which favour the development of this disease being eliminated so far as is possible. Branches which have been broken by wind or other agencies should be pruned back to the stem from which they arise and the cut surfaces treated with a suitable wound dressing.

Where *Calotermes* colonies are located in the wood of growing trees they may be destroyed by injecting Paris Green into the active termite workings. The simplest method of giving effect to this operation is to bore a 5/16 in. hole into the occupied galleries with a gimlet or auger and pump in the Paris Green powder by means of a rubber blower. An enema syringe of ball pattern and adult size is a very convenient article for this purpose and is cheap and procurable at any druggist's store. The bored hole should allow of the tapering nozzle of the syringe fitting tightly when introduced, to avoid a blow-back of the powder. The hole should be finally plugged with cement, asphaltum, tar and sand or other efficient seal and the surface neatly smoothed over with the finger. A little grease or oil applied to the finger will prevent the tar or asphaltum adhering.

COPTOTERMES

In 1927 a young *Hevea* stump was found to be attacked on an estate in the Ratnapura district by a ground-nesting termite which proved to be *Coptotermes ceylonicus*. It was the only case reported and it was thought at the time that the termites might have followed a fungus disease.

In March 1930, in connection with the treatment, at the Heneratgoda Botanic Gardens, of two old rubber trees for *Ustulina*, it was found that they had been completely hollowed out by *Coptotermes ceylonicus*. The trees in question are No. 24, in Plantation No. 1, planted in 1877 and No. 124, in Plantation No. 2, planted in 1886. The former tree has grown from one of the original *Hevea* seeds brought from the Amazon Valley by Sir Henry Wickham in 1876 and germinated at the Royal Botanic Gardens, Kew; before being sent to Ceylon. The tree is, consequently, of considerable historical interest. The tree is a large one being 8 feet in circumference one foot above ground level and $6\frac{1}{2}$ feet at a height of 3 feet from the ground. The tree has been completely hollowed to a height of 15 feet or more above soil level and the thickness of the remaining wood, surrounding the cavity, is not more than from $1\frac{1}{2}$ to 2 inches. The tree is apparently sound externally except for a hole at the base which penetrates to the central cavity, and the foliage is normal. It is reported that there has been no appreciable dimunition in yield of latex. Tree No. 124 is similarly attacked.

On looking up old records it was learnt that workers, soldiers, nymphs and adults of *Coptotermes ceylonicus* were collected from a *Hevea* tree in the Heneratgoda Gardens in 1909 but other details are lacking. No mention is made of this record by Petch [2] who was the collector of the specimens and it may be concluded that there was no reason, at the time, for regarding the insects as being responsible for direct injury to the tree from which they were taken.

In the section of the work referred to Petch states that termites are not pests of rubber in Ceylon as they are in Malaya, Java and Sumatra and explains this fact by the absence from Ceylon of *Coptotermes gestroi*, the notorious rubber termite of the latter countries. While this is true, the same genus is represented in Ceylon by two known species *C. ceylonicus* and *C. exiguus* and they are capable of behaving in precisely the same manner as their better known relative. They are both serious pests of living tea bushes in the low-country districts of Ceylon and the former has also been known to excavate the base of coconut palms in addition to other trees. The instances mentioned above also indicate that *C. ceylonicus* is capable of hollowing-out large *Hevea* trees and thus may threaten to earn for itself the same reputation as a major pest of rubber in Ceylon as its near relative has already done further East. Stages of this species are illustrated in Plate V.

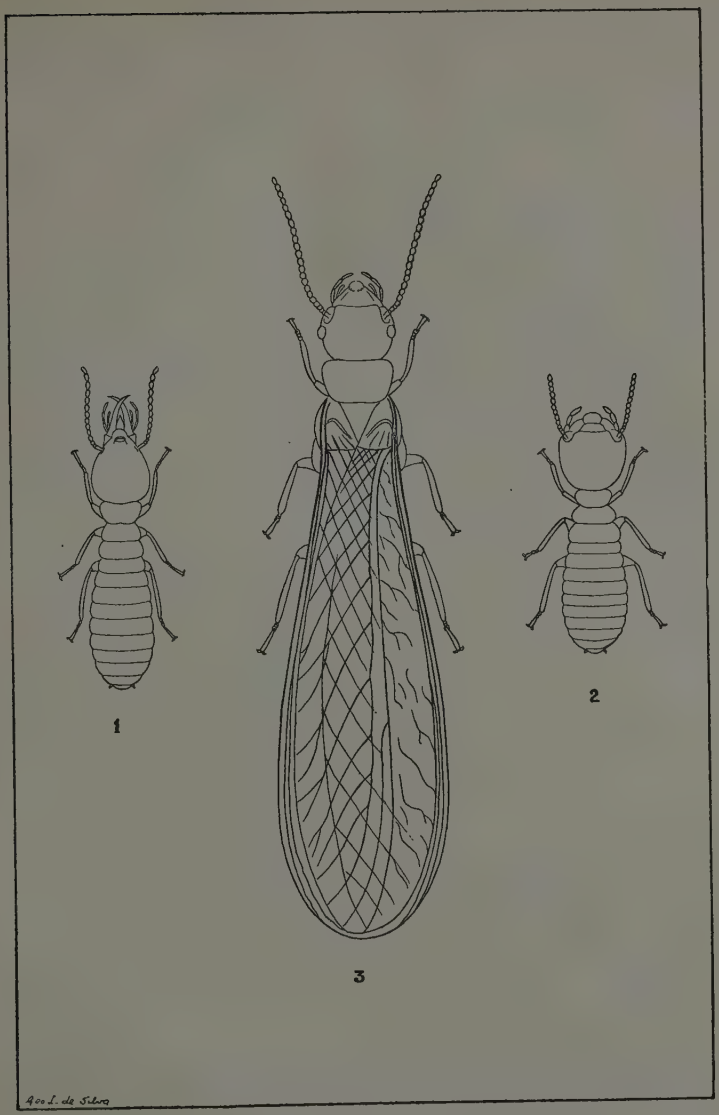

Plate V. *Coptotermes ceylonicus*

Fig. 1. Soldier X 10.

Fig. 2. Full-grown worker X 10

Fig. 3. Winged adult X 10.

The habits of the genus *Coptotermes* are, by no means, fully understood. It is believed that they usually enter their host-plants underground, through the roots, but their presence is rarely detected until very extensive excavation of the wood has taken place. The first indication of infestation may be the collapse of the attacked trees in wet weather and during high winds. One recent instance has been observed by the writer which indicated that *Coptotermes ceylonicus* was commencing to excavate a large *Albizzia* tree from above and not from below the soil. The infestation had apparently commenced at the base of a decayed branch about 15-20 feet from the ground and communication was being maintained with the soil beneath the protection of covered runways. The tree was sawn across 18 inches above soil level and there was no sign of any internal communication with a ground nest. Similar runways were observed on the outside of the trunk of a neighbouring tree of the same species, the objective again being a decayed branch. If extensive downward excavation of the type noted was allowed to continue undisturbed, the soil would eventually be reached and thus communication with the main soil nest would be established, when the previous external means of communication could be dispensed with. It should be mentioned that, so far as is at present known, *Coptotermes* is incapable of founding colonies in situations which are not immediately connected with the soil, and if such communication is interrupted the insects which are cut off from their bases must perish. *Coptotermes* is however, capable of surviving, if conditions are sufficiently moist, for a very much longer period when cut off in this manner than certain soil-nesting species of other genera, viz. *Termes*, *Cyclotermes* and *Hypotermes*.

It would appear, therefore, that *Coptotermes* may enter living trees in two ways. Entry through the roots cannot be prevented, but the absence of rotting snags will certainly reduce the danger of entry by the second method. All broken branches should be taken back to the point from which they arise on the larger branches, or even main stem when necessary, and the pruned surfaces suitably treated.

The species of *Coptotermes* are known to nest below the soil and the stumps of trees and buried logs form favourite centres for the headquarters of colonies. As in the case of other soil-nesting species the queen is a considerably distended individual, the enlargement being mainly in the abdominal region. Journeys of considerable extent are undertaken from the central nests and are said to have been traced for as great a distance as 100 yards. Under these circumstances attempts to destroy the insects under ground are valueless unless the central nests can be located and

this appears to be an extremely difficult undertaking. Further investigation regarding the most practical and economic methods of destroying the central nests is required. The removal of tree stumps from cultivated areas will certainly assist in reducing the points at which the formation of new colonies may commence and the operation is desirable for other reasons also as they are frequently the source of root diseases.

LOCAL DISTRIBUTION OF TERMITES KNOWN TO ATTACK HEVEA

The purpose of this article being to acquaint rubber planters with the present position in regard to this subject and to stimulate interest which might lead to further records of termite injury to *Hevea* being received, the known distribution in the Island of the termites referred to in the foregoing pages may be included with advantage. It is not suggested that these species do not occur in districts excluded from the following lists. The lists have been compiled from authentic records only and the distribution as given here is complete so far as it is known at the present time, but it is certain to be extended very considerably in the future.

Calotermes (*Glyptotermes*) *ceylonicus*.—Elpitiya, Hewaheta and Peradeniya.

Calotermes (*Glyptotermes*) *dilatatus*.—Ambalangoda, Avissawella, Balangoda, Chilaw, Deniyaya, Elpitiya, Galaha, Galle, Gampola, Horana, Ingiriya, Kadugannawa, Katugastota, Kegalle, Kiriella, Matugama, Opanake, Pelmadulla, Peradeniya, Ratnapura, Udugama and Yatiyantota.

Calotermes (*Neotermes*) *greeni*.—Ambalangoda, Avissawella, Badulla, Balangoda, Bandarawela, Bogawantalawa, Galaha, Gampola, Gampaha, Jaffna, Kadugannawa, Maskeliya, Peradeniya, Ratnapura, Rattota, Wattegama and Yatiyantota.

Coptotermes ceylonicus.—Ambalangoda, Avissawella, Balangoda, Chilaw, Colombo, Elpitiya, Gampaha, Gampola, Jaffna, Lindula, Maha-iluppalama, Matale, Matugama, Nawalapitiya, Pelmadulla, Peradeniya, Polgahawela, Puttalam and Rattota.

Although the other known local species of *Coptotermes*, *C. exiguus*, has not been found in *Hevea* it behaves in a manner precisely the same as that of *C. ceylonicus* from which it is not easily distinguished. This species has been found at Avissawella, Galaha, Kiriella, Peradeniya and Ratnapura. Similarly, the serious up-country tea termite *Calotermes* (*Neotermes*) *militaris* has not been found in rubber, but it has been collected from both tea and dadap on certain estates, or in districts, where rubber is grown. These districts are Deniyaya, Kadugannawa, Madulkelle, Rattota and Ratnapura. The distribution for other localities in which rubber is not grown is not included.

Further records of termites attacking *Hevea* will be welcomed. Specimens for identification, preserved in alcohol, or actually inhabiting the wood in which they are found, should be sent to the Entomological Division, Department of Agriculture, Peradeniya. Particular care should be taken, in all cases, to include specimens of the soldiers which, although not numerous, are present in most termite communities of any size and their conspicuous appearance cannot fail to reveal their presence if a little exploration of the infested wood is undertaken. Brief notes regarding type of attack, situation in which the specimens were found and other points of interest would also be very acceptable. The quest for specimens should be particularly directed to decayed branches and it is anticipated that if such branches are cut off and split open they will, in many cases, be found to harbour species of *Calotermes*. Narrow earthen runways up the main stem to rotting branches suggest *Coptotermes* and if these runs are broken the insects can be intercepted, on their return journey to their soil nests, and specimens collected as they cross the open spaces of the broken passages.

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A RECENT OUTBREAK OF *XYLARIA THWAITESII* ROOT DISEASE

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Occurrence in Ceylon.—*Xylaria Thwaitesii*, as a cause of root disease of *Hevea* in Ceylon, is of extremely rare occurrence. It was first recorded in 1910, but since this date it has been reported on only two or three estates. Throughout his visits to estates during the years 1922-1929, the Organising Secretary of the Rubber Research Scheme observed the disease on only one occasion. In May 1930 the writer visited an estate in Kegalle on which a number of trees attacked by *Xylaria* was found. It is of interest to note that so far as is known all the recorded cases of this disease have occurred in the Kegalle district, so that it would appear that the distribution of the fungus in Ceylon is very limited. *Xylaria Thwaitesii* has been reported on *Hevea* in Java and Indo-China, and in the former country is also responsible for a coffee disease.

A full description is given by Petch in the Year Book of the Department of Agriculture, Ceylon, (1923), from which an account was extracted and published in Rubber Research Scheme Quarterly Circular Vol. 1, Part 3, 1924. Since certain features which were observed in the recent outbreak have not been previously recorded, it was thought that a further description of the disease might be of interest to planters.

Symptoms.—The external mycelium of the fungus is represented by flat irregular bands of variable width on the surface of affected roots. These are white when young and are thus seen on the growing margin of the mycelium. They soon, however, become black and form an extensive network over the root, the bands coalescing in places to form irregular black patches. In this condition the external appearance is somewhat similar to an advanced case of "brown root" disease.

The inner cortex is yellowish-brown in colour, and friable. Where the tap root or a large lateral is attacked latex is often found to have exuded from the cortex in numerous places and formed large lumps of black scrap.

In advanced cases the appearance of the wood of diseased roots is quite characteristic. On splitting the roots longitudinally the central region is sometimes found to be greyish-brown in colour, the wood being hard yet moist. This region may be

delimited by a black line from the outer wood which is yellowish-brown in colour and somewhat more decayed. It is noteworthy that the wood remains quite hard until the final stages of decay. The extreme wetness of thoroughly diseased roots is a striking feature; on breaking a root water will often spurt into the face. This combination of hardness and wetness is quite distinct from the effect produced by any of the other root fungi.

On the estate in question there were more than 10 separate areas of infection, involving, in all, a large number of trees. In some trees only the lateral roots were affected, while in others the disease had spread to the tap root. None of the diseased trees had yet been killed, and the writer did not see any marked effect on the foliage. The rot of the roots is, however, quite complete and there is no doubt that affected trees would succumb in the course of time. The fungus appears to spread very slowly, and in this respect is probably comparable to *Fomes lamaoensis*, the cause of "brown root" disease.

The fungus will apparently not attack exposed portions of roots. Where an affected root comes to the surface the portion lying on and under the ground is diseased while the upper part exposed to the air is quite healthy. The margin of the diseased tissues is sharply delimited and becomes marked by a line of callus growth from the healthy portion. It is along this line, *i.e.*, where a diseased root comes to the surface, that the fructifications were mostly found.

Fructification.—The fructification consists of a cluster of club-shaped growths arising from a basal mass. Three or four stout stalks arise which may divide into numerous finger-like protuberances. When found in the field the "clubs" are usually a dirty white at the extremity, darkening in colour down to the base. Subsequently they turn black. The fructification is usually one to three inches in height, and the basal mass about two inches in diameter. Photographs of fructifications are shown in Rubber Research Scheme Quarterly Circular Vol. 1, Part 3, 1924.

When mature the upper part of the club-shaped stroma bears perithecia containing spores. Although no mature fructifications were found on the estate it is thought that fresh cases of infection are caused by wind dispersal of the spores.

Control.—The control measures to be adopted are the same as for other root diseases. The disease should be followed out to its furthest extremity in every direction, all affected roots taken from the ground and burned *in situ*, and an isolation trench dug outside the affected area. Trees on the margin of the diseased area having a few lateral roots affected may often be saved by amputating the diseased portions and tarring the wound.

On the estate visited over 100 trees have been treated and the spread of the disease has apparently been checked.

SOME COMMON PESTS AND DISEASES OF YOUNG *HEVEA* BUDDINGS

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THE recent increase in the use of valuable bud-grafted material has focussed attention on the ailments to which young shoots are liable. In the last few months many specimens of young bud-shoots have been received from estates with enquiries as to the most effective method of dealing with the pest or disease in question. The following note summarises the advice given. It is not an exhaustive list of the ailments which may appear in the budwood nursery, but deals only with those considered to be of importance.

Pests.—Amongst the various animals which attack young plants mites are the most important, and under certain conditions they may become a serious pest in nurseries. When an immature leaflet is attacked it becomes irregularly twisted and distorted and bears a strong resemblance to *Oidium* attack. Very young leaves may fall. The mites are usually found on the under side of the leaves, though often only their white cast-off skins are seen. With a lens the puncture holes in the epidermis, through which the cell sap is sucked, may be seen. Mites are often found in association with *Oidium* and other leaf-spotting fungi.

Mites are mostly to be feared in dry weather. Efficient control can then be secured by periodical dusting with the finest sulphur powder obtainable. Several makes of hand dusters suitable for use in nurseries are on the market. Alternatively sulphur can be applied by beating on a linen bag in which the powder is loosely contained. This method, however, is far less satisfactory since it is difficult to project the sulphur on to the under surface of the leaf where it is most required.

Slugs are often found to eat off the young terminal shoot. In the daytime it is usually possible to find the slugs underneath stones, etc. They may be to some extent discouraged by periodically dusting with smokehouse ashes, and by putting a barrier ring of ashes on the ground round each plant.

Lizards also give trouble by eating off the terminal bud, though they are seldom sufficiently serious to warrant special protective measures. It is probable that all animals such as lizards and slugs which attack young rubber shoots are to some

extent controlled by the application of any sulphur or copper fungicides which may be made in the control of the more serious affections.

Diseases.—*Oidium* may make its appearance in the budwood nursery. The symptoms of this disease are now too familiar to need further description, and can only be confused with an attack by mites. In common with the latter pest *Oidium* can be controlled by dusting with sulphur powder. Alternatively spraying with a solution of Sulfinette in water ($\frac{1}{4}$%-$\frac{1}{2}$%) will secure a fair measure of control.

Many estates which have established budwood nurseries with imported material have recently experienced trouble with a disease caused by *Phytophthora palmivora*. A full description of this disease was given in Rubber Research Scheme Quarterly Circular Vol. 7, Part 1, 1930. The green shoot is usually attacked a few inches below the extremity, though the disease has sometimes been found to originate at the base of the shoot, apparently arising from the bud patch. The disease first appears as a blackish, watery-looking, sunken area on the side of the stem, which spreads chiefly downwards and, unless checked, kills back the shoot to the extent of the latest growth increment. Secondary fungi gain entrance to the diseased portion and may hasten the die-back. More than one strain of the species can cause similar symptoms, and it is possible that new strains may have been introduced with imported budwood and budded stumps.

The disease is largely dependent on wet weather conditions, and is at once checked on the advent of a dry spell. In wet weather a careful watch must be kept in the budwood nursery since under favourable conditions the fungus is extremely virulent and kills back the shoot in a few days. Any diseased shoot must be cut back well below the affected part.

Effective control has been secured in several nurseries by spraying with Bordeaux Mixture. Since the efficiency of this fungicide is wholly dependent on its correct compounding the following instructions are given. The proportions are for a ·66% mixture which is considered the correct strength for the purpose.

Copper Sulphate	...	1 lb.
Freshly-burned lime	...	1 lb.
Water	...	15 gallons.

Dissolve the copper sulphate in one gallon of water in a wooden or earthenware vessel. The lime is slaked gradually for an hour or more, made into a uniform paste with water, and then made up to 14 gallons in a barrel. The copper sulphate is then poured into the milk of lime stirring all the while. On no account must iron vessels be used.

It is essential that all the copper sulphate should be neutralised by the lime. To test this hold a bright knife blade in the mixture for a minute. If it is tarnished a copper red more lime must be added. A more delicate test consists of adding a little weak potassium ferrocyanide solution to a few drops of Bordeaux Mixture in a saucer. A brown colour indicates excess of copper.

Unless a preservative is added Bordeaux Mixture does not keep and must be mixed freshly immediately before use. Since in the budwood nursery it will be necessary to use small quantities of the fungicide at relatively frequent intervals, it is useful to add a preservative to the mixture so that it is not necessary to make it up freshly on each occasion. For this purpose dissolve pure cane sugar in the copper sulphate at the rate of 1 oz. to 10 gallons of the completed mixture. The mixture may then be kept in a covered receptacle for some weeks and, after shaking, used when required. The Chemist has found that the sugar bought locally in "Kaddais" does not possess as good preservative qualities as pure cane sugar, so the latter article should be used.

If *Phytophthora* infection occurs in the budwood nursery all the young shoots should be sprayed with Bordeaux Mixture once a week. The spraying can be safely discontinued in dry weather.

Conclusion.—It is a sound rule which has been recommended to several estates that all young shoots in a nursery of valuable bud-grafted material should be dusted with sulphur powder every 10 days in dry weather, and sprayed with Bordeaux Mixture every week or 10 days during wet weather, the applications being discontinued when the shoots are a few months old. Such treatment will reduce to a minimum the risk of damage by any of the pests and diseases mentioned above. It must be emphasised that for effective prevention all shoots, whether diseased or healthy, must be treated.

PROPOSALS FOR FURTHER DUSTING EXPERIMENTS AGAINST *OIDIUM* ON KANDANUWARA ESTATE, MATALE

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A field of 30 acres was dusted with five applications of sulphur during January to March 1930. The foliage was definitely benefited by the treatment and the results have been reported on. Yield records are being taken from a number of plots in the dusted field, and, as a control, from the same number of plots in a neighbouring undusted area. It is not anticipated that an increased yield in the dusted as compared with the undusted rubber will be obtained for a considerable time, and it is therefore necessary that the dusting should be continued for several seasons. It is proposed that a further programme of dusting be carried out in 1931.

The degree of control of the disease obtained in the previous experiments is not considered entirely satisfactory. In the Mycologist's Report for April 1930 several reasons for the comparative failure were set forth; they are reproduced below:

(1) The disease was fully active when dusting operations were commenced.

(2) A considerable proportion of trees had already suffered defoliation before dusting was commenced.

(3) Too long an interval elapsed between the first and second applications.

(4) At least two further applications should have been made in March and April.

(5) Possibly the quantity of sulphur applied at each dusting was insufficient. This was certainly the case for the fifth and final dusting.

(6) Reinfection from neighbouring undusted rubber.

So far as is possible these points will receive special consideration during the next series of experiments, and every endeavour will be made to secure as complete control of *Oidium* as possible. The factors will be considered individually:

(1) and (2) Dusting operations will be commenced earlier than previously. By making the first application in November 1930 it is hoped that the fungus may be to some extent controlled before attaining its full virulence. Unfortunately November and December are wet months on the estate and attempts to make an application may be frustrated. Any opportunity afforded by a dry spell of weather will be taken.

(3) The interval elapsing between successive applications in November and December must be largely governed by the weather conditions obtaining.

(4) Provision will be made for continuing the applications of sulphur until as great as possible a measure of control has been secured.

(5) A larger quantity of sulphur per acre will be applied in the first two dustings.

(6) Reinfection from neighbouring undusted rubber is unavoidable. This factor is not, however, considered to be of great importance in the field in question.

NOTES ON THE APPEARANCE OF SAMPLES OF SMOKED SHEET AND BLANKET CREPE FROM ESTATES

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SAMPLES of smoked sheet and blanket crepe were provided recently by a large number of Ceylon estates for the purpose of an investigation of variability of plasticity. This investigation is being carried out by the London Branch of the Research Scheme at the Imperial Institute, but before being despatched to London the samples were carefully examined from the point of view of appearance, and it is considered to be of interest to record the conclusions which were reached with regard to the general standard of appearance of the rubber. For the information of the superintendents who kindly provided the samples it should be stated that it will be a considerable time before the results of the plasticity tests are available. Variations in plasticity develop during storage and the samples will therefore be stored at the Imperial Institute for 6 months before the tests are started. There will then be a further period of at least six months before the investigation is completed.

SMOKED SHEET

A total of 204 samples was received, but a small number arrived too late to be included in the present classification which refers to 195 samples.

General Attractiveness.—The samples were divided into 3 grades representing the general attractiveness of the rubber, with out taking into consideration the presence of specific defects which are mentioned later; the result of the classification being as follows:

Good	140 samples	72 %
Medium	48 samples	24·5%
Bad	7 samples	3·5%

It was considered that sheets classified as "good" would secure a ready sale at full market price and in some cases at a small premium. The "medium" sheets would find a less ready market, which is a matter of importance when an excess of the commodity is available and this in some cases would lead to disposal at a slight discount. The "bad" sheets were distinctly below the market standard of appearance.

These samples can be regarded as fairly representative of Ceylon estate smoked sheet and it is very satisfactory that the output from nearly 75% of the estates can be classed as attractive in appearance. The samples classed as "medium" would also in most cases have been in the higher class if a little more care had been taken in manufacture, and this could be done without any material increase in cost of production. Some of the common reasons for rejection of samples were:—uneven smoking, dark reaper marks, light reaper marks, uneven shape, grit and other foreign matter in the rubber, uneven and pitted surface. It is true that (with the exception of grit) these defects have no relation to the quality of the sheets, but the fact remains that rubber is sold on appearance, and when supplies are plentiful it is only natural that the buyer will give preference to the rubber which appears to have been most carefully prepared.

Bubbles.—The number of sheets affected with bubbles was as follows:

Slight	26	13·5%
Medium or bad	7	3·5%

In most cases of "slight" bubbles the defect was due to fermentation at the edges of the sheet, and could be avoided by more careful washing of the pans and troughs, or if necessary by the use of disinfectants.

"Rust" and Mould.—Eight of the sheets were affected with rust and in only three cases was it severe. Some years ago rust was one of the most common defects of Ceylon smoked sheet, but ceased to be a source of trouble when its cause was understood, and suitable precautions were taken to prevent its development.

The samples were not tested for resistance to mould, and only a few samples which were stored at the laboratory during wet weather developed the defect. Immunity from trouble with mould can be secured by means of paranitrophenol at a cost not exceeding 0·175 cents per pound of rubber, and the use of this chemical can be regarded as an economy on any estate where conditions of preparation, transport or storage lead to trouble with mould.

Stickiness.—Smoked sheet is not often penalised on account of surface stickiness, but it is of interest to record that the samples which were examined showed very material differences in this respect. From experiments which are at present being carried out by the Research Scheme it appears that the occurrence of surface stickiness in smoked sheet depends on the balance between smoke and heat in the drying house. Sheet dried at raised temperature without smoke is distinctly sticky and the higher the temperature of drying, the greater the density of

smoke required to prevent the development of stickiness. There is also another type of stickiness due to the sheets "sweating" which arises from lack of ventilation in the smokehouse.

The degree of stickiness was judged by the feel of the sheets and the result of the classification was as follows:

A	Non-sticky	103	53 %
B	Slightly sticky	66	34 %
C	Medium ,,	16	8 %
D	Very ,,	9	4·5%
E	Almost tacky	1	0·5%

Class A and B can be regarded as normal and satisfactory. Class C and D would be likely to cause comment by the brokers. The sheet in Class E was distinctly below the standard of first grade rubber.

Size, thickness, colour and marking.—It is only to be expected that the samples would vary materially in these factors, which are governed largely by the equipment available, such as type of machinery and pans, smokehouse dimensions, etc.

Size.—The size of the sheet is not unimportant in relation to economy of packing space, the ideal being that the sheet should just fit the packing chest, *i.e.*, should be approximately 23 ins. × 18 ins. A sheet of this size weighing 1½ lb. is very suitable in thickness for efficient drying. In many cases wide sheets cannot be prepared owing to unsuitable reaper spacing or the use of narrow rollers, but care should be taken that the sheets are of the correct length. Packing is then fairly economical if the extra width of the chest is occupied by sheets packed on edge. Sheets which are longer than the chest are particularly uneconomical, as they must either be trimmed, with loss of first grade rubber, or doubled over which interferes with packing.

The sample sheets were classified according to length with the following results:

Less than 21 inches	77	39·5%
21-24 inches	91	46·5%
More than 24 inches.	27	14·0%

The saving which can be effected by economical packing may vary from 0·1-0·2 cents per lb. for rubber sold locally, to 0·5 cents or more if the rubber is sold in distant markets.

Thickness.—Thin sheets dry rapidly but it may not be economical from the point of view of hanging space and handling to make them very thin. Also a thin sheet gives an impression of weakness, and requires heavier smoking to give the same colour as a thicker sheet more lightly smoked. On the other hand the time of drying increases disproportionately if the sheet is too thick.

The thickness of the sheets was calculated from the dimensions and weight of the samples in terms of weight (in grams) per square foot. The figure varies slightly according to the pattern of the marking roller but gives a fairly satisfactory index of thickness. It is considered from recent experiments that a thickness of 225-250 grs. (8-9 ounces) per square foot is a suitable average for rapid drying and good appearance.

The thickness of the samples examined is summarized as follows:

Thinnest sheet	173 grams per square foot.	
Thickest sheet	372 grams per square foot.	
Thin sheets (less than 225 grs. per sq. ft.)	19	10%
Medium sheets (225-300 grs. per sq. ft.)	131	70%
Thick sheets (more than 300 grs. per sq. ft.)	38	20%

(A few sheets were not measured owing to unusual pattern of the marking roller).

Colour.—The colour required in smoked sheet depends largely on the taste of the buyer, and a sample which is considered too dark by one broker may well be rejected as too light by another who is buying for a different market. Generally speaking, a well smoked sheet is to be preferred as being more resistant to mould.

The sample sheets were roughly classified according to colour, but the classification is influenced by the prevailing "fashion" in colour. Sheets classed as medium colour would probably have been regarded as too light a few years ago.

Light	22	11·5%
Medium	105	53·5%
Dark	60	31·0%
Very dark	8	4·0%

Pattern of marking roller.—Generally speaking, the small pattern produced by a spiral roller with close grooves is most pleasing in appearance and most useful in hiding roughness and other defects in the sheet, but from a number of the samples it was evident that sheet with wide marking can also be very attractive if the marking is distinct and the rubber clear and smooth.

The primary object of marking the sheets with a pattern is to increase the rate of drying by exposing a greater surface area to the air. An average smoked sheet is approximately $\frac{1}{8}$ inch thick on the ridges and it follows that the most suitable type of marking from the point of view of efficient drying, is such that the sheet is divided into a series of ridges $\frac{1}{8}$ inch thick and $\frac{1}{8}$ inch wide, with narrow furrows between the ridges. The proviso

should be made that if the furrows are too narrow and deep, water may lodge in them and give rise to "rust." A marking roller which is in use at the laboratories has grooves $\frac{1}{8}$ inch wide and deep with $\frac{1}{8}$ inch between the grooves and produces a sheet of attractive appearance and good drying properties. In the finished sheet there are 5 ridges per inch, the ridges being approximately $\frac{1}{8}$ inch wide, while the furrows are slightly less than $\frac{1}{8}$ inch wide.

The presence of a pattern on smoked sheet also reduces the tendency of the sheets to stick together when packed, sheets marked with narrow ridges having less tendency to stick than those with broad ridges. Sheet with large spaces between the ridges is uneconomical for packing, and this is a material point in comparing the amount packed per chest on different estates.

The pattern of the sample sheets was measured with the following results:

Close marking (5-6 ridges per inch)	101	67·5%
Medium marking (4-4$\frac{1}{2}$ ridges per inch)	18	12·0%
Wide marking (less than 4 ridges per inch)	8	5·5%
Diamond marking	23	15·0%

(Total examined 150 sheets).

SUMMARY

In general it may be concluded that about 75% of Ceylon estate smoked sheet, as represented by the 200 samples attains a high standard of appearance. A further 20% could probably be brought up to this standard by increased care in preparation. In the case of the remaining 5%, it is likely that reorganisation of methods of preparation, and improvement of equipment are required.

BLANKET CREPE

It is usually considered that the manufacture of good quality blanket crepe is easier than the preparation of good quality smoked sheet, and in conformity with this view it was found that the differences in the appearance of the samples of blanket crepe were less marked than were found in the samples of smoked sheet.

Colour.—The chief aim in preparation of blanket crepe is to secure a good colour but it is not easy to compare the colour of various samples without making allowance for factors such as the thickness of the rubber and the age of the sample at the time of examination. It was also unfortunate that a proportion of the samples were supplied soon after the resting period when the colour of the rubber is abnormal; and several planters queried whether such samples could be regarded as suitable for the purpose of plasticity tests. Evidence is available regarding the changes in plasticity when new cuts are opened and a suitable adjustment can be made for such samples.

There were indications that some of the samples had depreciated in colour much more rapidly than others.

The colour of the 114 samples was roughly judged as follows:

Pale	10	9·5%
Medium	66	63·0%
Off	11	10·5%
New cuts	18	17·0%

The above classification does not include 9 samples which had been in store for several months and were noticeably off-colour. It is considered that the pale and medium samples were up to the market standard, and in fact in some cases the "medium" samples were more attractive in appearance than those classified as "light." The "off" samples would probably sell at a small discount. Five of the samples appeared to be machine dried and of these one was classified as "medium" and the other four as "off."

Five samples had a slight streakiness which is frequently a cause of trouble in marketing blanket crepe.

Hardness.—There were very material differences in the hardness of the samples. Generally speaking, the market prefers a hard gristly crepe, but it is probable that the average manufacturer's requirements would be better met by a comparatively soft crepe, especially if this is reflected in improved plasticity. Experiments carried out by the Research Scheme (R.R.S. Bulletin 49 p. 7) indicate that machine-dried crepe and crepe blanketed in hot rollers have improved plasticity.

The samples were classified as follows:

Very soft	2*	2·0%
Soft	21	18·5%
Medium	54	47·5%
Hard	26	22·5%
Very hard	11	9·5%

* machine dried.

Texture of Rubber and Size and Thickness of Pieces.—The type of rolling to which the samples had been subjected in the blanketing process differed materially. Rolling in a machine with even speed pinions, operated at a comparatively low speed tends to produce a smooth, evenly marked product. On the other hand a machine with a large difference in speed between the two rolls, especially if operated at high speed, results in uneven marking which is less attractive in appearance.

The width of the samples naturally varied considerably. A number had been rolled in wide machines and were of the correct size to fit the packing chest, but of the others a proportion were

not of a convenient width for packing. When the rubber is blanketed in a 15-inch machine it is preferable to fit hoppers to reduce the rolling width to $10\frac{1}{2}$-11 inches so that the sheets of rubber can be packed side by side in the chest. The proportion of samples which were of suitable width for economical packing was approximately 65%.

The thickness of the rubber also varied considerably. Generally speaking, the preparation of thick blanket saves time in rolling and is more economical for packing, but tends to make the rubber appear darker in colour. The thickness of the samples was calculated as weight (in grams) per square foot. Hitherto a thickness of 16 ounces (454 grams) per square foot has been regarded as an average for Ceylon blanket crepe, but judged by this series of samples the average is somewhat higher viz., 18 ounces per square foot. The result of the examination was as follows:—

Less than 400 grams per sq. ft.	24	21·0%
400-600 grams per sq. ft.	71	62·0%
More than 600 grams per sq. ft.	17	15·0%
Lace crepe		2·0%

Thinnest sample 261 grams per sq. ft.
Thickest sample 914 grams per sq. ft.

SUMMARY

The conclusion reached from examination of the 114 samples of blanket crepe is similar to that for smoked sheet, viz., that a large proportion of the samples attain a high standard of appearance. It is difficult to give precise figures for the crepe samples as the appearance depends so largely on colour, which deteriorates during storage. It can however be estimated roughly that 85% of the samples were good, 10% indifferent, and in the remaining cases that re-organisation of manufacture is required.

In a number of samples the general appearance could have been improved considerably by greater care in blanketing.

NOTICES.

SUBSCRIPTIONS.

Arrangements have now been made for Bulletins and Circulars of the Ceylon Rubber Research Scheme to be made available to non-contributors to the Scheme at the rate of Rs. 15-00 per annum, post free.

GLASS HYDROMETERS.

Glass hydrometers for testing latex and for testing formic acid as specified and as recommended by the Rubber Research Scheme (Ceylon) may be obtained at a cost of Rs. 12·50 and Rs. 10·50 each respectively, from :—

Messrs. WALKER, SONS & Co., Ltd.,
Engineering & Estate Supplies Department,
Colombo.